Claims

What is claimed is:

1. A combustor comprising:

a pilot nozzle being provided in a center portion of a combustor main body;

a plurality of main nozzles being provided in a surrounding area of the pilot nozzle at regular intervals;

a pilot cone covering a downstream-side tip portion where a fuel of the pilot nozzle flows and having tip portion thereof provided with a tapered portion of inner circumference of a cone which has a tapered shape in a radial pattern toward downstream side; and

pilot swirls being installed so as to be in contact with an inner wall surface of the pilot cone and supporting the pilot nozzle in a center portion of the pilot cone:

wherein, a fuel being injected from fuel injection ports which are provided to an outer circumference of a tip of the pilot nozzle and inject a fuel bumps against an inner wall surface of the tapered portion of inner circumference of a cone from a position being half as long as the tapered portion of inner circumference of a cone to a downstream-side tip.

2. A combustor as described in Claim 1:

wherein, when an opening angle of the pilot cone is "θ," a spray angle "α" of a fuel being injected from the fuel injection ports which are

provided to an outer circumference of tip of the pilot nozzle and inject a fuel satisfies:

$$-90° \leq \alpha < -\theta/2,\ \theta/2 < \alpha \leq 90°$$

3. A combustor comprising:

a pilot nozzle being provided in a center portion of a combustor main body;

a plurality of main nozzles being provided in a surrounding area of the pilot nozzle at regular intervals;

a pilot cone covering a downstream-side tip portion where a fuel of the pilot nozzle flows and having tip portion thereof provided with a tapered portion of inner circumference of a cone which has a tapered shape in a radial pattern toward downstream side; and

pilot swirls being installed so as to be in contact with an inner wall surface of the pilot cone and supporting the pilot nozzle in a center portion of the pilot cone:

wherein, when an opening angle of the pilot cone is "θ," a spray angle of a fuel being injected from fuel injection ports which are provided to an outer circumference of a tip of the pilot nozzle and inject a fuel is "θ/2"; and the fuel is injected in parallel with inclination of the tapered portion of an inner circumference of a cone.

4. A combustor as described in Claim 3:

wherein, a distance "c" between a jet flow of a fuel being injected from the pilot cone and a tapered inner wall surface of the tapered portion of inner circumference of a cone is "$c < 1/2\ (B - D)$," wherein a diameter of a downstream-side tip of the pilot cone is "B" and a diameter of a pilot nozzle is "D."

5. A combustor comprising:

a pilot nozzle being provided in a center portion of a combustor main body;

a plurality of main nozzles being provided in a surrounding area of the pilot nozzle at regular intervals;

a pilot cone covering a downstream-side tip portion where a fuel of the pilot nozzle flows and having tip portion thereof provided with a tapered portion of inner circumference of a cone which has a tapered shape in a radial pattern toward downstream side; and

pilot swirls being installed so as to be in contact with an inner wall surface of the pilot cone and supporting the pilot nozzle in a center portion of the pilot cone:

wherein, the said pilot nozzle comprises:

a first fuel supply channel being provided in a center portion of the pilot nozzle and letting a large amount of fuel being supplied to the pilot nozzle pass through;

a second fuel supply channel being provided to a surrounding area of the first fuel supply channel and letting a remaining fuel being supplied to the pilot nozzle pass through;

a cylindrical pilot nozzle cover whose outer wall surface is in contact with an inner wall surface of the pilot swirls, covers a downstream-side tip of the pilot nozzle and induces air passing through an outer circumference of the pilot nozzle to a downstream-side tip of the pilot nozzle;

a first fuel injection pipe which is provided to an outer circumference of a downstream-side tip of the pilot nozzle, penetrates through the pilot nozzle cover from the first fuel supply channel, and injects a fuel being supplied from the first fuel supply channel to an outer circumference of the pilot nozzle cover; and

fuel injection ports which are provided to a position being more upstream side than the first fuel injection pipe on an outer circumference of the pilot nozzle and are connected to the second fuel supply channel so as to inject a fuel being supplied from the second fuel supply channel to an area consisting of the pilot nozzle cover and the pilot nozzle.

6. A combustor as described in Claim 5:

wherein, the pilot nozzle cover comprises:

a first cylinder cover being in contact with inner wall surfaces of the pilot swirls and covering a downstream-side tip of the pilot nozzle from a position which is more upstream side than a position of the pilot swirls to a position which is more downstream side than a position of the fuel injection

ports; and

a second cylinder cover being provided to a position which overlaps the first cylinder cover and is between the pilot nozzle and the first cylinder cover, wherein the first fuel injection pipe penetrates through.

7. A combustor as described in Claim 6:

wherein, the second cylinder cover covers a downstream-side tip of the pilot nozzle from a proximity of the fuel injection ports.

8. A combustor as described in Claim 6:

wherein, the pilot nozzle is provided with a second fuel injection pipe which penetrates from the fuel injection ports to the second cylinder cover and injects a fuel being supplied from the second fuel supply channel to an area consisting of the first cylinder cover and the second cylinder cover.

9. A combustor as described in Claim 6:

wherein, the first cylinder cover is installed in a manner that a downstream-side tip of the first cylinder cover comes to more upstream side than the first fuel injection pipe.

10. A combustor comprising:

a pilot nozzle being provided in a center portion of a combustor main body;

a plurality of main nozzles being provided in a surrounding area of the pilot nozzle at regular intervals;

a pilot cone covering a downstream-side tip portion where a fuel of the pilot nozzle flows and having tip portion thereof provided with a tapered portion of inner circumference of a cone which has a tapered shape in a radial pattern toward downstream side;

pilot swirls being installed so as to be in contact with an inner wall surface of the pilot cone and supporting the pilot nozzle in a center portion of the pilot cone; and

a cylinder being in contact with a downstream-side surface of the pilot swirls and coming to proximity of an outer wall surface of the pilot nozzle being located more downstream side than the pilot swirls, tip portion of the cylinder being provided with a tapered collar being shaped in a radial pattern toward a downstream side

11. A combustor as described in Claim 10:

wherein, the collar is provided so that a downstream-side tip of the collar is located more upstream side than a position where a jet flow of fuel being injected from the pilot nozzle bumps against the collar.

12. A combustor as described in Claim 10:

wherein, the collar is provided so that a downstream-side tip of the collar is located more downstream side than a position where a jet flow of fuel being injected from the pilot nozzle bumps against the collar.

13. A combustor comprising:

a pilot nozzle being provided to a center portion of a combustor main body;

and bypass pipes being connected to bypass valves which bypass an air not being used for combustion to a downstream side of a combustor and being provided to a top side of a combustor main body; and

wherein, the pilot nozzle is provided with a plurality of fuel injection ports injecting a fuel being supplied to the pilot nozzle and being installed to an outer circumference of downstream-side tip of the pilot nozzle, at positions excluding a position which is nearest to the bypass pipes.

14. A combustor comprising:

a pilot nozzle being provided to a center portion of a combustor main body; and

connection pipes being provided to a side surface of a combustor main body propagating flames to another combustor; and

wherein, the pilot nozzle is provided with a plurality of fuel injection ports injecting a fuel being supplied to the pilot nozzle and being installed to an outer circumference of downstream-side tip of the pilot nozzle, at positions excluding a position which is nearest to the connection pipes.

15. A combustor comprising:

a pilot nozzle being provided to a center portion of a combustor main body ; and

bypass pipes connecting to bypass valves which bypass air being not used for combustion to a downstream side of a combustor and being installed to a top side of a combustor main body; and

wherein, the bypass valves are slightly opened.

16. A combustor comprising:

a pilot nozzle being provided in a center portion of a combustor main body;

a plurality of main nozzles being provided in a surrounding area of the pilot nozzle at regular intervals;

a pilot cone covering a downstream-side tip portion where a fuel of the pilot nozzle flows; and

main burners covering downstream-side tip portions of the main nozzles; and

wherein, the pilot cone comprises:

a tapered portion of inner circumference of a cone being formed in a tapered shape so as to stretch out in a radial pattern toward a downstream side; and

a collar portion which is provided to an external periphery of a downstream-side tip of the tapered portion of inner circumference of a cone and serves as a surface being approximately vertical to axial direction of the said pilot nozzle; and

wherein, an angle in axial direction to a line connecting an external periphery of a downstream-side tip of the pilot nozzle and an external periphery of downstream-side tips of the main burners is specified as "αx," an opening angle of the tapered portion of inner circumference of a cone "θ" is "$0 \leq \theta < 2\alpha x$."

17. A combustor as described in Claim 16:

wherein, an outer circumference of the tapered portion of inner circumference of a cone is provided with a cylinder being shaped so as to be along an outer wall of the tapered portion of inner circumference of a cone and the collar portion.

18. A combustor as described in Claim 17:

wherein, a downstream-side tip of the cylinder is placed so as to be located in proximity of an external periphery of downstream-side tips of the main burners.

19. A combustor as described in Claim 16:

wherein, the collar is installed to more downstream side than downstream-side tips of the main burners for several millimeters.

20. A combustor as described in Claim 16:

wherein, the tapered portion of inner circumference of a cone is provided with a cylindrical portion which is extended from a joint portion with the collar portion in the tapered portion of inner circumference of a cone, having a same opening angle "θ"as the tapered portion of inner circumference of a cone.

21. A combustor as described in Claim 20 :

wherein, are provided with a first cylinder having a first collar portion which covers from downstream-side tips to upstream side of the main burners on an outer circumference of the tapered portion of inner circumference of a cone, serves as a surface being vertical to axial direction of the pilot cone, and extends toward positions of downstream-side tips of the main burners on downstream-side tips thereof; and

a second cylinder having a second collar portion which covers from downstream-side tips of the main burners to downstream side on an outer circumference of the tapered portion of inner circumference of a cone, is placed at upstream-side tips thereof, and faces the first collar portion.

22. A combustor as described in Claim 20:

wherein, a length being along the cylindrical portion in the cylindrical portion of the tapered portion of inner circumference of a cone is one through three times as long as a vertical length against axial direction of the pilot cone in the collar portion.

23. A combustor as described in Claim 16:

wherein, the collar portion is installed more upstream side than downstream-side tips of the main burners; and

wherein, the collar portion has a cylindrical portion in a tapered shape, being along an outer walls of the main burners from an external periphery of the collar portion to downstream-side tips of the main burners.

24. A combustor as described in Claim 23:

wherein, the tapered portion of inner circumference of a cone has a cylindrical portion extending from a joint portion with the collar portion in the tapered portion of inner circumference of a cone, having a same opening angle "θ" as the tapered portion of inner circumference of a cone.

25. A combustor as described in any of Claims 16 through 24:

wherein, a plurality of flame-stability-enhancing fuel supply channels are provided so as to pass between the pilot cone and the main burners and supply a fuel to downstream-side of the collar portion being connected to the tapered portion of inner circumference of a cone.

26. A combustor as described in Claim 25:

wherein, the flame-stability-enhancing fuel supply channels are installed so as to be located on a line connecting the main nozzles and the pilot nozzle.

27. A combustor comprising:

a pilot nozzle being provided in a center portion of a combustor main body;

a plurality of main nozzles being provided in a surrounding area of the pilot nozzle at regular intervals;

a pilot cone covering a downstream-side tip portion where a fuel of the pilot nozzle flows; and

main burners which cover downstream-side tips of the main nozzles; and

wherein, the pilot cone comprises:

a tapered portion of inner circumference of a cone being provided to downstream-side tip portion and being formed to be tapered, extending in a radial pattern toward a downstream side; and

a double cylinder , wherein a first cylindrical portion being provided to an outer circumference of the tapered portion of inner circumference of a cone is connected to a second cylindrical portion having a wider opening angle than the first cylindrical portion and being provided to an outer circumference of the first cylindrical portion, at upstream-side tip portions thereof, respectively.

28. A combustor as described in Claim 27:

wherein, an outer circumference of the double cylinder is provided with a cylinder being shaped so as to be along an outer wall of the second cylindrical portion.

29. A combustor as described in Claim 27 or Claim 28:

wherein, a plurality of flame-stability-enhancing fuel supply channels are provided so as to pass between the pilot cone and the main burners and supply a fuel to a hollow being formed by the first and the second cylindrical portions of the double cylinder.

30. A combustor as described in Claim 29:

wherein, the flame-stability-enhancing fuel supply channels are installed so as to be located on a line connecting the main nozzles and the pilot nozzle.

31. .A combustor comprising:

a pilot nozzle being provided in a center portion of a combustor main body;

a plurality of main nozzles being provided in a surrounding area of the pilot nozzle at regular intervals;

a pilot cone covering a downstream-side tip portion where a fuel of the pilot nozzle flows; and

main burners which cover downstream-side tips of the main nozzles; and

wherein, the pilot cone comprises:

a tapered portion of inner circumference of a cone being provided to downstream-side tip portion and being formed to be tapered, extending in a radial pattern to proximity of downstream-side tips of the main burners,

a first cylindrical portion protruding from an external periphery of downstream-side tip of the tapered portion of inner circumference of a cone to centers of the main burners;

a second cylindrical portion protruding from an external periphery of downstream-side tip of the tapered portion of inner circumference of a cone to centers of the main burners: and

a cylinder being formed so as to be along an outer wall of the tapered portion of inner circumference of a cone and have downstream-side tip thereof be in contact with downstream-side tips of the main burners.

32. A combustor as described in Claim 31:

wherein, a length of the second cylindrical portion is approximately same as a length of the first cylindrical portion.

33. A combustor as described in Claim 31:

wherein, the second cylindrical portion is formed so as to be closed

toward downstream side within a range between 0 degree and 60 degrees against axial direction of the pilot cone.

34. A combustor as described in any of Claims 31 through 33:

wherein, a plurality of flame-stability-enhancing fuel supply channels are provided so as to pass between the pilot cone and the main burners and supply a fuel to an area being surrounded by the first and the second cylindrical portions.

35. Combustor as described in Claim 34:

wherein, the flame-stability-enhancing fuel supply channels are installed so as to be located on a line connecting the main nozzles and the pilot nozzle.